PhysicsFlash
April 2018
Approved for public release; distribution is unlimited.

INSIDE

Career destination: Los Alamos

Discovering fulfillment and opportunities as Physics Division researchers

Meet Physics Division's newest converted staff researchers: Young Jin Kim (Applied Modern Physics, P-21), Matt Freeman and Ralph Massarczyk (Neutron Science and Technology, P-23), and Xuan Li, Kun Liu, Levi Neukirch, and Zhaowen Tang (Subatomic Physics, P-25). These staff members conduct a range of applied and fundamental research—from making precision magnetic measurements to constructing sensitive detectors that may show how matter evolved and to exploring physics beyond the Standard Model.

Some first experienced the Laboratory as summer students, others as postdoctoral researchers. All decided to continue their careers as full-time staff members, citing a number of reasons, including

- the Lab's breadth of available research opportunities,
- its friendly yet competitive work environment,
- the Lab's connection to the Manhattan Project, and
- the area's climate and mountains.

Becoming a Los Alamos staff scientist is no small accomplishment in the competitive world of national laboratory research. Postdoctoral researchers must demonstrate exceptional scientific capabilities based on work performed, research published and presented, and interactions with colleagues. Division management selects the most promising candidates while considering diversity and the programmatic and strategic needs of its groups, the division, and the Laboratory. Read on to get acquainted with some of Physics Division's newest staff members.

continued on page 3

Los Alamos NATIONAL LABORATORY EST. 1943

"I am committed to having a diverse workforce in the division. Diversity encompasses more than gender and ethnicity. It includes diversity of backgrounds and skills. Consider the path that the person took to get where they are today. I look forward to welcoming the new hires into the division."

David

From David's desk . . .

Welcome to spring. For some of us, it is also welcome to allergy season, but hopefully the end of flu season. We are coming upon fire season. Please be aware that this could be a very dangerous season and act accordingly outdoors. It is important that the group offices have your emergency contact information.

This issue highlights some of our newest staff researchers: Young Jin Kim (Applied Modern Physics, P-21), Matt Freeman and Ralph Massarczyk (Neutron Science and Technology, P-23), and Xuan Li, Kun Liu, Levi Neukirch, and Zhaowen Tang (Subatomic Physics, P-25). I hope that you enjoy reading about their varied backgrounds and interests.

LANL expects to replace approximately one third of its staff over a five-year period, much of this due to anticipated retirements. While the fraction may not be quite as large in Physics Division, we are planning for a significant number of staff hires over the next few years. This means that many of you will be asked to serve on hiring committees. I thank you in advance for your help in these efforts. There are some things that I would like you to consider when you serve on the committees. We are hiring for the future and hope that many of staff will have long careers at LANL. Thus, we need to hire the best and brightest, not just for the immediate task, but for their career. I am committed to having a diverse workforce in the division. Diversity encompasses more than gender and ethnicity. It includes diversity of backgrounds and skills. Consider the path that the person took to get where they are today. I look forward to welcoming the new hires into the division.

Once we have hired the best and brightest, the next task is retention! As I have said previously, I expect Physics Division to have a professional working environment where all staff are treated with respect and where opinions are sought from all and listened to. The institution is trying to help with recruiting and retention. I was very pleased to see LANL add paid maternity leave to the benefits package. This is important for retaining a diverse workforce.

A Mamava lactation pod has been installed in Building 86 at TA-35 (photo below). I thank Sha-Marie Reid (P-24) and Rocco Intriere (MSS-STO) for making it happen. This is the second pod installed in Physics Division space.

I thank Mel Borrego (P-27) for his 26 years of service to the nation, in active military duty and the National Guard. You can read about his last major contribution in this issue.

As always, it is a pleasure to congratulate recent award winners from the division. In this issue you can read about Brenda Dingus (P-23) receiving the 2017 Medal from the Mexican Physical Society's Division of Particles and Fields (mentioned in this column previously), Hanna Makaruk (P-21) being named one of the 2018 New Mexico STEM women of the year, and the Neutron Diagnosed Subcritical Experiments (NDSE) team (P-21, P-23, and P-27) receiving a 2016 NNSA Defense Programs Award of Excellence. Other divisions shared in this award, XCP, XTD, NEN, MST, ADW, ADX, J, T, & C.

Finally, as you know, LANL is in the middle of the contract transition process, with a new contractor expected to be named in the next few months. I realize that change can be stressful. Please focus on the work that you need to deliver and try not to be distracted by the transition. If you have any concerns, I would be happy to talk to you, but I don't have much information beyond what is publicly available.

Have a wonderful Spring in New Mexico.

Physics Division Leader David Meyerhofer

Career cont.

YOUNG JIN KIM

Applied Modern Physics, P-21
Scientist

Young Jin Kim graduated from Indiana University at Bloomington with a Ph.D. in physics and an enthusiasm for the range and depth of research conducted at the Lab. She joined Los Alamos as a postdoctoral researcher working on several exciting projects focused on the detection of ultra-small magnetic signals, including searching for the neutron electric dipole moment, detecting explosives using a nuclear quadrupole resonance, and developing an ultra-sensitive magnetic microscope. Kim credits mentors Igor Savukov and Andrei Matlashov (P-21), Michelle Espy (Applied Engineering Technology, AET-6), and Steven Clayton (Subatomic Physics, P-25) with providing professional advice and exposing her to a range of research projects.

A drive for R&D
Since my childhood, I have been enchanted by books and movies that show futuristic worlds with flying cars, people traveling into space, and robots. That was the driving force for me to get into physics. Research and development in physics really attracted me.

Fine-tuned skills
I conduct precision magnetic measurements ranging from ultra-sensitive micro-magnetic imaging to fundamental discrete symmetries testing with very sensitive magnetometers, superconducting quantum interference devices, and atomic magnetometers. The conducted research will lead to novel applications for biomagnetism and provide tremendous impact on our understanding of nature.

Progress report
It was a memorable day when I gave my talk for my conversion to a staff member, in which I summarized all my progress on the projects that I worked on during my postdoc. In this talk, I discussed precision magnetic measurements from explosive detection, discrete symmetries testing, and micro-particle imaging. It gave me a great opportunity to look back over my postdoc years.

Discoveries ahead
I'm excited to propose a new idea for research and development.

MATT FREEMAN

Neutron Science and Technology, P-23
Scientist

Matt Freeman came to Physics Division and Lab mission-related research by an unconventional background. His Ph.D. from Duke University is in medical physics, which is primarily the physics of diagnostic imaging and radiation therapy for cancer treatment. Freeman soon learned that many of the techniques that process images of the human body can also be used to process proton radiography data—hence his transition to Los Alamos and the Proton Radiography Facility.

Expanding proton radiography applications
I am working on finding ways to develop the capabilities of proton radiography for new applications relevant to the Lab's mission and as a tool for guiding proton beam therapy cancer treatments, which relates to my background in medical physics.

continued on next page

Career cont.

In the cancer research world, high-energy protons are taking off as the most accurate way to deliver a dose of radiation. Currently, I am working on a Laboratory Directed Research and Development program-funded project to develop proton radiography as an image guidance tool that increases the accuracy of proton beam therapy. Our goal is to create the highest quality radiograph with the lowest possible radiation dose. This project has the potential to change the field of proton beam therapy. Any developments on this front that improve the image quality, contrast, and resolution of proton radiography have immediate benefit to every Lab experiment that we do.

Most memorable day as a LANL postdoc

Any day that I have given a talk, for me, is memorable because of how nervous I get beforehand. And among those talks, the presentation that I gave for the Laboratory's “Science-in-3” postdoc career development series was farthest from my comfort zone, as it was in front of a largish audience that was mostly not from a physics background. But I ended up with an award for my presentation that (Principal Associate Director for Science, Technology, and Engineering) Alan Bishop presented me with, so that was probably my most memorable day so far.

Field goals

When I was converted to staff, the best advice that I got was to find something big and make it happen within five years. When I look around at other junior staff, for example, Sky Sjue (P-21) has developed an accurate forward model of proton radiography that is blisteringly fast and Johnny Goett (P-23) has developed an ultrafast 10-frame camera that is peerless in its capabilities. In that regard, the bar is very high. I am not sure what my big contribution will be yet, but I am always thinking about it.

RALPH MASSARCZYK

Neutron Science and Technology, P-23
Scientist

With a master’s and a Ph.D. in physics from Germany’s Technical University Dresden and an interest in exploring other cultures, Ralph Massarczyk applied for a postdoctoral position at the Laboratory. Nuclear physicist Steve Elliott, P-23’s weak interactions/astrophysics team lead, contacted Massarczyk and shared his expansive knowledge of the MAJORANA project, a large international collaboration developing an instrument to search for the rare signal of neutrinoless double-beta decay. Massarczyk liked the idea of conducting measurements that could prove whether or not the neutrino is its own anti-particle and the challenge of building the sensitive detector.

Going underground

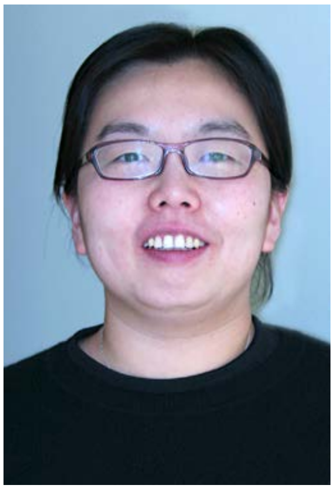
My first day underground at the Sanford Underground Research Facility in South Dakota was unforgettable. To go a mile deep through a dirty mine, change clothes, and stand in a cleanroom and see all these shiny things in the middle of an old gold mine was breathtaking. It’s the coolest place in the world to work and I am part of it.

The fundamentals

I do research in neutrino physics, especially neutrinoless double beta decay. It’s very fundamental research that can help us to understand the nature of the neutrino and can explain the creation of matter and antimatter in the universe. We are working on new detector technologies and analysis methods to find one of the rarest processes in the universe and pushing new innovations from which the Lab can benefit. These low background technologies needed to find our process can be used for monitoring in nuclear safeguards.

continued on next page

Role model
I would say about a third of my decision to stay at the Lab is because of Steve Elliott, a Laboratory Fellow and our team lead. He is the best physicist I ever met. He has such a wide range of interests and knowledge and triggers the work in our group with new ideas every day. He supported my work in every way, introduced me to new people, and I can discuss my ideas with him at any time.



XUAN LI

Subatomic Physics, P-25
Scientist

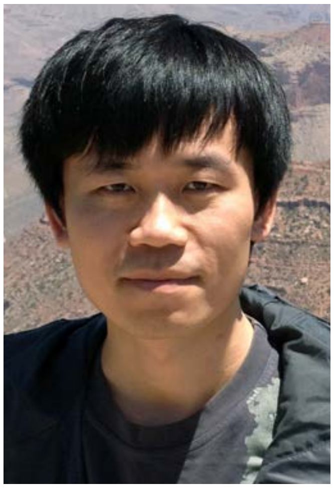
High-energy and nuclear physics scientist Xuan Li started researching fundamental particles with silicon detectors in 2015 as a Los Alamos postdoctoral researcher. She came to the United States from the coastal city of Jinan, China, where she received a Ph.D. in high-energy and nuclear physics in 2012 from Shandong University, finishing her thesis research at Brookhaven National Laboratory.

On the frontline
Los Alamos has played a leading role in the nuclear physics field worldwide since it was founded. It's an honor to be part of the Lab and to continue frontline research studies in high-energy and nuclear physics. Beyond the fundamental science, Los Alamos provides multiple opportunities to extend the basic science studies to applied physics.

Future prospects
I got strong support from our team and group colleagues at the Lab to carry out new research topics and achieve physics results. I had opportunities to work on both basic science and applied physics as a postdoc. I would like to continue my career at Los Alamos to pursue my current research programs and extend my research scope to more broad topics.

Goal setting
I'm working on several research programs now. My research goals are to explore how the extremely hot, dense nuclear medium called the quark gluon plasma (QGP) is formed and how QGP properties reveal the state of the early universe. I'm doing data analysis to use heavy quark probes to study the QGP properties at PHENIX experiment. I have done R&D for a next-generation silicon vertex detector based on the monolithic active pixel sensor (MAPS) design. The detector is essential for a unique heavy ion experiment called the sPHENIX physics program, which will start in about five years at the Relativistic Heavy Ion Collider in the United States and will help ensure Los Alamos's leading role in the high-energy and nuclear physics field. To extend the application of the MAPS detector, I am working on feasibility tests of MAPS x-ray imaging. I contribute to muon radiography gas electron multiplier (GEM) detector R&D work and plan to help build a portable GEM detector to image industrial infrastructure with cosmic ray muons.

continued on next page



KUN LIU

Subatomic Physics, P-25
Scientist

Ever since he was introduced to Los Alamos through a history book, working at the Lab was Kun Liu's dream. With Ph.D. in particle physics from China's Peking University, he joined Los Alamos as an off-site graduate student in 2011. During this posting at the Fermi National Accelerator Laboratory, he was part of the original team that built equipment and wrote code for SeaQuest, an experiment studying the quark and anti-quark structure of the nucleon. On his first day as a postdoctoral researcher, excited about being a part of Los Alamos, he spent the whole night calling friends and a high school teacher to tell them where he was.

History buff
When I was 13, I read a book named "The Glory and the Dream: A Narrative History of America, 1932–1972." One chapter was dedicated to the Manhattan Project and the early beginning of Los Alamos. I was fascinated by the description of the first test at the Trinity site and learned that all the sand underneath melted to form a green glass that was sold as souvenirs. I really wanted to buy a piece to decorate my desk. All my interest in physics and dream of at least visiting Los Alamos starts from that time.

Professional pointers
Pat McGaughey (P-25) is essentially a living history of the field I'm studying and he gives me the feeling that he knows everything. Every time I scratch my head over a problem for a few days, I go to him and he usually has answers or points me in the right direction within minutes. Just amazing.

Future endeavors
I'd love to have the chance to participate in other aspects of the Lab's mission in addition to the fundamental science I'm doing right now. Although I'm technically an experimental physicist, I spend a lot of my time writing software and would like to eventually get more involved in the Lab's supercomputing work.

LEVI NEUKIRCH

Subatomic Physics, P-25
Scientist

Los Alamos sped to the top of Levi Neukirch's list of places for a "real job" when he first joined the Lab as a undergraduate summer student from the University of Nebraska. Neukirch found himself loving the area's weather, landscape, and green chile. After receiving his master's and Ph.D. in physics from the University of Rochester in New York, he returned as a postdoctoral researcher on the Proton Radiography team doing diagnostic work and instrument development, including instrumentation for x-ray imaging, optical velocimetry, and fast proton detection.

Examining the universe
Physics is the most fundamental study of our natural world. It's what allows us to understand so many other fields of science. In school, it seemed like any type of science we were doing fell back on basic physics at some point. Want to understand chemical reactions and bonding? Learn electricity and magnetism and quantum mechanics. Want to understand hydrology or plate tectonics? Learn mechanics and fluid dynamics. I quickly decided that if I was going to be a scientist, I should start at what seemed to be the foundation.

continued on next page

Career cont.

In the mix

Proton radiography provides a unique radiographic capability that serves both the weapons program and fundamental materials science experiments. I do a mix of operational and development work, coordinating experiments involving personnel from multiple organizations at the laboratory and developing new instrumentation. Since converting I've taken on a lead role in a project to enable proton energy loss measurements at pRad. This will provide a second probe of target areal density and increase both the quantity and quality of measurements we can make.

Words to the wise

Nobody looks out for you like you. Be alert, opportunistic, and open-minded. Know what you're good at, and what you're not so good at.

ZHAOWEN TANG

Subatomic Physics, P-25
Scientist

Attracted to physics by the challenge of solving fundamental scientific problems, Zhaowen Tang earned his bachelor's of science from the University of Texas at Austin and his Ph.D. in physics from Indiana University. He joined Los Alamos as a postdoctoral student, working on Ultracold Neutron Facility upgrades to enable room-temperature neutron electric dipole moment experiments with a factor of 10 improvement over current experimental sensitivity. The search for the neutron electric dipole moment probes time reversal invariance violation beyond the Standard Model of physics, and it can shed light into the matter-antimatter asymmetry of the universe.

From ultracold neutrons to proton radiography…

I decided to come to Los Alamos because of the cutting-edge research that was going on at the Ultracold Neutron Facility. The team I worked with was conducting important experiments that probe physics beyond the Standard Model. I now work on proton radiography at Los Alamos. The research involves radiographing dynamics experiments that will provide important experimental data to the weapons program at the Lab.

…and a lot in between

I very much enjoyed the time I have spent as a postdoc, and I have learned very much in the process. Los Alamos offers excellent research opportunities in many different fields. In particular, the Laboratory has a world-class proton radiography facility, and I was very excited about the broad range of research I could get involved with in proton radiography as well as multidisciplinary collaborations that have come into fruition because of the diverse research environment at the Lab.

Motivating forces

I had the good fortune of being surrounded by a team of great scientists that has contributed to my success. I have received a lot of scientific and technical advice that has greatly helped my scientific career and much professional advice that contributed to my staying at the Lab.

Physics Division staff in the news

Mel Borrego aids Puerto Rico recovery efforts as part of National Guard deployment; retires from military service after 26 years

Physics Division research technologist and U.S. Army National Guard Command Sergeant Major Mel Borrego recently returned to the United States and the Laboratory after more than a month aiding Puerto Ricans as part of recovery and relief efforts following Hurricane Maria.

In September the Category 4 hurricane made a direct hit on the U.S. island territory, leaving many of its residents homeless and without food and water. The Federal Emergency Management Agency called the hurricane the largest federal response to a natural disaster in the history of the United States.

In November Borrego (LANSCE Weapons Physics, P-27) and his Rio Rancho-based New Mexico Army National Guard unit, the 111th Sustainment Brigade, were called to help with relief efforts. Borrego and his unit served as the Joint Task Force-Puerto Rico Command, coordinating support to provide rapid and flexible help to the civilian population at the Puerto Rico Joint Operations Area. Day to day, Borrego's main mission was to take command of the units supporting distribution of food, water, and fuel, as well as establishing communications and engineering support throughout the island.

Puerto Rico was Borrego's last tour of duty; he retired from the Guard in February, after serving for 26 years in active duty and the National Guard. During his distinguished career, he garnered accolades including the Meritorious Service Medal, Overseas Service Ribbon, Global War on Terrorism Service Medal, the Combat Action Badge, and

Mel Borrego takes a break from delivering commodities to have a photo taken with a young resident of the town of Loiza.

Army commendation medals. He was named the 2003 New Mexico Army National Guard Non-Commissioned Officer of the year.

Borrego said he sees several parallels between his recent work in Puerto Rico and the missions he has supported over the years. "Whether or not you wear the uniform, deep down inside you want to help," he said. "When I'm out there, I notice the gratitude among people... I also notice how everyone comes together to help each other. From talking to the people of Puerto Rico I have no doubt they will come back even stronger, just like the people of New Orleans after

Continued on next page

At left, Mel Borrego (center) and fellow Guardsmen from New Mexico and Puerto Rico distribute water and other essentials to people in the town of Veja Alta.

In the news cont.

Hurricane Katrina and Los Alamos after the Cerro Grande and Las Conchas fires."

Borrego, who has been a Physics Division research technologist for more than 20 years, expressed gratitude to the Lab for supporting him and his family during missions. The Lab was accommodating and flexible when Borrego was called suddenly into duty and maintained communication when he was on missions.

"It's been a privilege to wear the uniform and the honor of serving my country and my community. To work alongside my fellow soldiers and the people of Puerto Rico in the rebuilding for my last time in uniform is something I will cherish for the rest of my life."

Technical contact: Mel Borrego

Brenda Dingus receives Mexican Physical Society's 2017 Medal

Brenda Dingus (Neutron Science and Technology, P-23) received the 2017 Medal from the Mexican Physical Society's Division of Particles and Fields. The award honors her developments to physics in Mexico, particularly her work establishing the High-Altitude Water Cherenkov Gamma-Ray Observatory (HAWC) in the state of Puebla, Mexico and her ongoing work on the HAWC project. The medal is the society's highest distinction and recognizes notable contributions by Mexican scientists or foreigners to the development of particle and field physics in Mexico.

Dingus, who has more than two decades of experience in gamma-ray astronomy, has been involved in some of the field's most important discoveries. She is widely known in the gamma-ray community for her pioneering work in gamma-ray bursts and her contributions to the relatively young field of very high-energy gamma-ray astronomy.

Dingus was the DOE principal investigator for and managed the construction of HAWC. She has held two two-year terms as the project's U.S. spokesperson and from 2010 to 2014 led the HAWC collaboration team—comprising 140 scientists from 23 United States and Mexican institutions. Her vision, leadership, and management made the Laboratory an internationally recognized leader in observational astrophysics and part of a wider network of land- and satellite-based telescopes probing the universe to answer fundamental questions.

She received a Ph.D. in experimental cosmic-ray physics from University of Maryland, College Park in 1988 and joined Los Alamos in 2002. Dingus is the recipient of numerous awards and honors, including a Los Alamos Distinguished Performance Award, a Presidential Early Career Award for Scientists and Engineers, and Los Alamos National Laboratory and American Physical Society fellowships.

The Mexican Physical Society (Sociedad Mexicana de Física, in Spanish) is a non-profit organization founded in 1951 to promote research and teaching in physics, to foster interest in science and especially physics among people in Mexico, and to establish close links with similar organizations within Mexico and abroad. The society has 1,400 members and 13 topical divisions.

Technical contact: Brenda Dingus

Hanna Makaruk named a New Mexico STEM Woman of the Year

Hanna Makaruk (Applied Modern Physics, P-21) was named a New Mexico STEM Woman of the Year 2018 by the New Mexico Supercomputer Challenge.

She is among a dozen honorees who were chosen for "the grace and grit at which they pursue life and career" and who are featured in the 2018 "New Mexico Women in STEM" calendar. To highlight successful women in STEM, the calendar is being sent to math and science teachers throughout the state.

Makaruk, who has a Ph.D. in applied science from the Polish Academy of Sciences and a master's in physics from the University of Warsaw, began working as an assistant professor at the Polish Academy of Sciences in 1994 before joining Los Alamos as a Director's Postdoctoral Fellow in 1996.

At Los Alamos, she conducts scientific research in image and experimental data analysis, has authored more than 40 open scientific publications and book chapters and nearly 200 LANL classified reports, and is a data validation and archiving project leader. For 15 years she has volunteered with the Institute of Electrical and Electronics Engineers and

Continued on next page

In the news cont.

for nearly two decades has organized American Mathematical Society sectional meetings.

Also recognized as STEM women of the year were Sandra Begay (Sandia National Laboratories), Karissa Culbreath (University of New Mexico [UNM] Pathology), Anita Lee Gallegos (Leidos), Marisol Gamboa (Lawrence Livermore National Laboratory), Sara Hartse (Delphix), Angela Palacios James (New Mexico Fish and Wildlife Conservation Office), Rochelle Larsen (CDM Smith), Marie Reyes (South Valley Academy), Katie Richardson (Office of United States Senator Martin Heinrich-State Science and Development), Valerie Romero-Leggott (UNM Health Sciences Center/Office of Diversity), and Lydia Tapia (UNM Computer Science Department).

Founded in 1990, the Supercomputing Challenge is a nonprofit educational organization that sponsors an annual computational science competition for middle and high school students in New Mexico. The competition is designed to interest students in science, technology, engineering, and math (STEM) fields and to promote networking between local tech firms and students.

The calendar, which is available for purchase, was also sponsored by the Albert I Pierce Foundation, DataONE, EPSCoR, Lodestar Reinsurance, University of New Mexico, and private donations.

Technical contact: Hanna Makaruk

Physics Division researchers receive NNSA award for new technique to measure subcritical systems

Members of Physics Division were recognized with a 2016 NNSA Defense Programs Award of Excellence for their efforts developing the neutron diagnosed subcritical experiment (NDSE) in collaboration with researchers at the Nevada National Security Site and other Lab divisions. The annual Defense Programs Awards recognize significant achievements in quality, productivity, cost savings, safety, or creativity in support of NNSA's Stockpile Stewardship Program.

NDSE is a new technique being developed to measure the nuclear reactivity of a dynamic subcritical system with an accuracy comparable to that obtained on supercritical systems during the era of underground nuclear tests. No such measurements have been made on nuclear weapon stockpile relevant systems since the end of testing, but recent technology advances coupled with improved computational tools are now available to enable the development of NDSE. Recent successful demonstrations of these prototype technologies, both through individual characterization tests and integrated proof-of-principle experiments, are pushing NDSE development toward a diagnostic capability that could be

The next stage of the NDSE will be to measure a dynamic (imploding) and fissile plutonium target. This will require building the NDSE in the U1a underground facility at the Nevada National Security Site, shown here. (Photo courtesy NNSS)

fielded in U1a on future subcritical experiments (SCE) using plutonium.

Four key components are required to successfully demonstrate NDSE as a viable SCE diagnostic: a robust and reliable short-pulse neutron source, a detector with sufficient sensitivity to measure the emission of fission gamma rays without being contaminated by neutron background signals, collimation and shielding designs to sufficiently suppress neutron and gamma ray scattering into the detectors, and forward modeling simulation capabilities to design the SCE experiments and analyze the data. The large team of nominated individuals, both from Los Alamos National Laboratory and the Nevada National Security Site, contributed to significant advancements in all four of these areas.

Physics researchers contributing to NDSE were Russell T. Olson, Robert S. King, and Anemarie DeYoung (Neutron Science and Technology, P-23); Vincent W. C. Yuan (Applied Modern Physics, P-21); and Paul E. Koehler (LANSCE Weapons Physics, P-27). George L. Morgan (formerly P-23, now retired) served as a consultant on the project.

Other Los Alamos team members were from Monte Carlo Codes, XCP-3; XTD Primary Physics, XTD-PRI; Advanced Nuclear Technology, NEN-2; Engineered Materials, MST-7; AD Weapon Engineering and Experiments, ADW; AD Weapons Physics, ADX; DARHT Operations, J-1; DARHT Experiments and Diagnostics, J-4; Nuclear and Particle Physics, Astrophysics, and Cosmology, T-2; and Nuclear and Radiochemistry, C-NR.

The work supports the Laboratory's Stockpile Stewardship mission area and its Nuclear and Particle Futures science pillar. Initial funding for NDSE development came from a Laboratory Directed Research and Development project led by DeYoung. The program is now funded by the NNSA Experimental Sciences Program.

The Award of Excellence was presented at a November 2017 ceremony.

Technical contact: Russ Olson

Ultracold Neutron Facility performance upgrade could help spell out signature for the nEDM

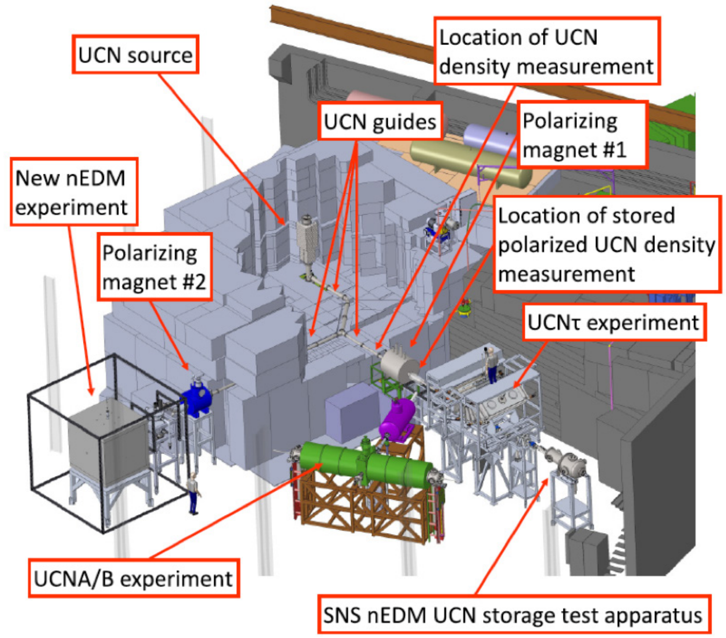
Improvements could demonstrate existence of the elusive particle physics measurement, lead to future fundamental science discoveries

Los Alamos National Laboratory researchers and their collaborators executed a major upgrade to the ultracold neutron (UCN) source at the Los Alamos Neutron Science Center (LANSCE). The improvements make possible a more sensitive search for the neutron electric dipole moment (nEDM). Scientists have searched for this particle physics signature for nearly 60 years. Confirming its existence could explain the apparent imbalance of matter and antimatter in the universe.

The lack of sufficiently strong sources of UCNs has hampered search efforts worldwide. Evaluations indicated an upgrade of the Los Alamos source would provide the necessary UCN density for such an experiment with the required sensitivity. The Ultracold Neutron Facility's source produces high-energy spallation neutrons provided by the LANSCE linear accelerator and uses solid deuterium to cool the neutrons by one million billion-fold. It is the first production UCN source based on superthermal UCN production and the only operational source of UCNs in the United States. Successfully operated for over a decade, the facility has been instrumental to numerous fundamental particle physics experiments, providing UCNs to the UCNA, UCNB, and UCNτ studies and to development work for the nEDM and Nab experiments at Oak Ridge National Laboratory's Spallation Neutron Source.

The work to upgrade the source started in the fall of 2014, and included replacing the horizontal UCN guide and designing and replacing a cryostat insert that maximized the stored UCN density in the nEDM cell at the planned experiment location. Experimental and theoretical research resulted in a prototype nEDM experimental apparatus, improved UCN density, and measurements indicating the source performs as modeled, producing a UCN density at the exit of the biological shield that is a fourfold increase from the highest previously reported. The researchers, taking into account the nominal LANSCE accelerator running schedule and assumed data-taking efficiency of 50%, estimate that the required sensitivity for an nEDM experiment could be achieved in five years or less.

With the improvements, the UCNτ (neutron lifetime) experiment is routinely collecting data sufficient for a 1-s statistical uncertainty in the free neutron lifetime in an actual running time of approximately 60 hours. The upgraded source will enable other UCN-based experiments, such as improved measurements of the neutron β asymmetry.



The layout of the Los Alamos Ultracold Neutron Facility at the Los Alamos Neutron Science Center. In this illustration part of the biological shield is removed to show the ultracold neutron (UCN) source and guides.

The work was funded by Los Alamos's Laboratory Directed Research and Development Program through the Directed Research project "Probing new sources of time-reversal violation with neutron EDM," the U.S. Department of Energy, and the U.S. National Science Foundation. It supports the Laboratory's fundamental science mission area and its Nuclear and Particle Futures and Science of Signatures science pillars by aiding the development of expertise and capabilities required for its national security science missions. LANSCE, an accelerator-based national user facility for national security research and fundamental science, is principally sponsored by the National Nuclear Security Administration.

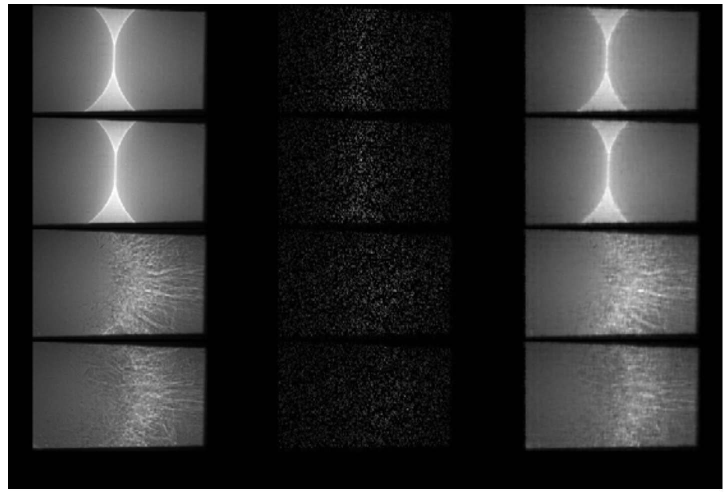
Researchers: T. M. Ito, S. M. Clayton, S. Currie, D. E. Fellers, S. MacDonald, M. Makela, C. L. Morris, R. W. Pattie, Jr., J. C. Ramsey, A. Saunders, Z. Tang, and H. L. Weaver (Subatomic Physics, P-25); S. Sjue (Applied Modern Physics, P-21); W. Wei (Computational Physics, CCS-2); E. R. Adamek, N. B. Callahan, and D. J. Salvat (Indiana University, Bloomington); J. H. Choi and A. R. Young (North Carolina State University); C. Cude-Woods (P-25 and North Carolina State University); X. Ding (Virginia Polytechnic Institute and State University); P. Geltenbort (Institut Laue-Langevin, France); S. K. Lamoreaux (Yale University); C.-Y. Liu (P-25 and Indiana University, Bloomington); E. I. Sharapov (Joint Institute of Nuclear Research, Russia); and A. P. Sprow (University of Kentucky). Eric Brosha (Materials Synthesis and Integrated Devices, MPA-11) and other researchers helped the team characterize a coating. Michael Mocko (LANSCE Weapons Physics, P-27) assisted in the use of a computer cluster.

Technical contact: Takeyasu Ito

New sparse imaging method demonstrates possibilities for advanced high-speed x-ray camera designs

A multi-institutional effort led by Physics Division researchers demonstrated a new sparse imaging method that could advance the state of ultrafast imaging now enabled by the combination of the latest developments in synchrotrons, x-ray free-electron lasers (XFELs), and computation and data handling. Imaging technology continues to be a stumbling block to the full use of the powerful illumination offered by synchrotrons and XFELs, which attract tens of thousands of researchers each year.

The team's novel method uses an on-board sampling technique that provides 10 times data reduction (see figure), a high-speed imaging technology advance that could enable and accelerate big-data-driven material discoveries through, for example, machine learning and artificial intelligence.



Left column shows raw images taken using an existing high-speed camera. The middle column shows a random sampling of the raw imaging with only 10% of the original data. The right column shows reconstructed images using 10% raw data and sparse imaging codes generated by PetaVision open source toolbox.

Until recently, high-speed imaging development has been centered on hardware that can take more than a decade to develop from concept to working prototype. Sparse sensing, also known as compressed sensing or compressed sampling, is revolutionizing imaging by combining hardware and data innovations to accelerate high-speed imaging development and applications.

Using x-ray images from the Advanced Photon Source synchrotron at Argonne National Laboratory, the team illustrated the feasibility of random on-board pixel sampling and described a possible circuit architecture to achieve random pixel access and in-pixel storage through a combination of multilayer architecture, sparse on-chip sampling, and computational image techniques. Ongoing work has shown that a similar approach can be extended to the time-domain for time-sparse high-speed imaging.

The work supports the Lab's Nuclear Deterrence mission area and its Materials of the Future and Science of Signatures science pillars. The Los Alamos portion of the work is funded by MaRIE technology risk mitigation. The research could benefit the design of light sources such as that planned for MaRIE, the Laboratory's proposed experimental capability for studying matter-radiation interactions in extremes. MaRIE would feature a hard x-ray free electron laser and in situ characterization tools that enable dynamic, in situ, and multi-modal mesoscale materials studies.

Researchers: Zhehui Wang (Subatomic Physics, P-25), Oleksandr Iaroshenko and G. Kenyon (Information Sciences, CCS-3), S. Li (Applied Mathematics and Plasma Physics, T-5), P. Chu (Neutron Science and Technology, P-23), T. Liu and P. R. Lipton (Fermi National Accelerator Laboratory), N. Parab (Argonne National Laboratory), W. W. Chen (Purdue University), and K.-X. Sun (University of Nevada, Las Vegas).

Accepted for publication in *Journal of Instrumentation*.

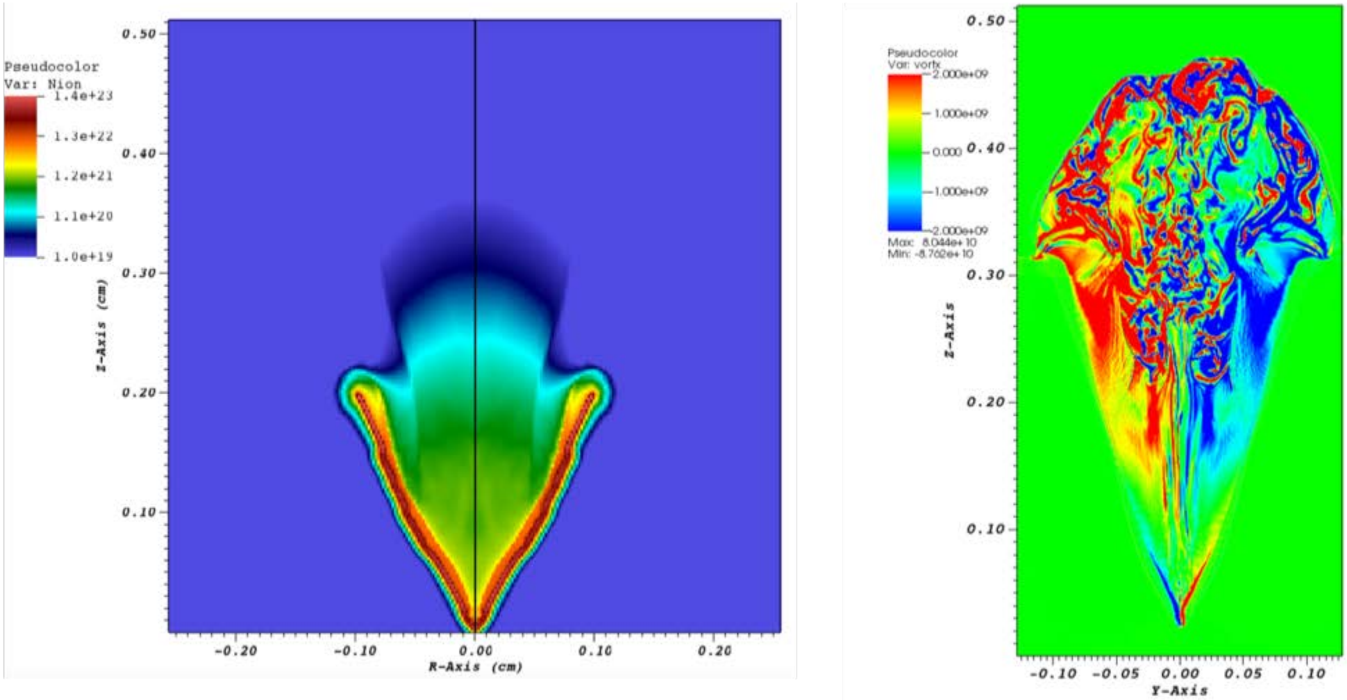
Technical contact: Zhehui Wang

Platform proposed for new laboratory astrophysics and ICF experiments

A multiyear collaboration led by Los Alamos National Laboratory researchers with their colleagues at University of Michigan and University of Chicago is developing turbulent magnetic dynamo and Biermann battery platforms for future studies on astrophysical processes and inertial confinement fusion (ICF). Kirk Flippo (Plasma Physics, P-24) presented the multiyear study at a recent talk on progress in ICF and high energy density research.

Astronomical observations have shown that most of the universe is ionized, magnetized, and often turbulent and filled with jets. However, many questions have not been thoroughly understood, such as how the universe became magnetized and how enormous jets form over galactic distances. One theorized process to create and amplify magnetic fields to such superstrong strengths to pervade the universe or collimate jets is the turbulent magnetic dynamo, a seemingly fundamental yet

Continued on next page



FLASH simulations showing a simple cone geometry (left), with symmetric laser spots hitting the inside of the cone walls, which produce a laminar plasma plume (density is shown, no vortex structures), and same cone (right) with the laser field staggered in a three-dimensional configuration, which produces a highly turbulent plume (vorticity is plotted showing the myriad small-scale vortices).

Platform cont.

poorly studied phenomena in plasma physics that involves converting kinetic energy into magnetic energy. This process is basic to understanding planetary physics and astrophysics and could explain phenomena from stellar explosions to earth's magnetic field, galactic jets, and even the intergalactic magnetic field.

Using experiments on the Omega and Omega EP lasers at the University of Rochester, New York, the research team is developing a basic science platform with a turbulent plume of magnetized material to study the turbulent magnetic dynamo, its nonlinearities, and the saturation processes. The researchers are developing a platform to study the Biermann battery B-field generation process under ICF-like conditions and to evaluate the impact to ICF implosions. In the former, the laser interaction with the target itself can seed magnetic fields that can be advected into the plume and then amplified to saturation by the turbulent magnetic dynamo process. In the latter, a "void" (of lower density or gas) is subjected to a shock that produces B-fields via the Biermann battery process, independent of the laser. In both projects, the resulting plume and "void" characteristics can be diagnosed with charged particles. The results will be compared to hydro code calculations to refine models of the turbulent dynamo and Biermann processes, which may have large implications for ICF.

If strong B-fields, or fields above 10 T, can be spontaneously generated in ICF-like conditions and compress to fields that are 10-100 times higher, it would mean a paradigm shift in modeling and simulating ICF implosions, as this would require magnetohydrodynamic modeling to understand how these fields change the heat conduction inside an implosion and the dynamics by shifting material around. All this could explain why ICF capsules underperform, compared to hydro models.

This work uses Lab-supported diagnostics at the Omega and Omega EP laser systems. The projects are funded by Los Alamos's Laboratory Directed Research and Development program and the Lab's Center for Space and Earth Sciences. It supports the Laboratory's Energy Security and Stockpile Stewardship mission areas and its Nuclear and Particle Futures science pillar.

Researchers: Kirk Flippo and Alexander Rasmus (Plasma Physics, P-24); Hui Li (Nuclear and Particle Physics, Astrophysics, and Cosmology, T-2); Shengtai Li (Applied Mathematics and Plasma Physics, T-5); Tana Cardenas (Engineered Materials, MST-7); Carolyn Kuranz, Joseph Levesque, and Sallee Klein (University of Michigan); and Petros Tzeferacos (University of Chicago).

Technical contact: Kirk Flippo

A simple correlation for neutron capture rates from nuclear masses

Recent studies of neutron capture performed at Los Alamos have revealed a previously unrecognized connection between nuclear masses and the average neutron capture cross section. A team of scientists from LANSCE Weapons Physics (P-27), Yale University, and Istanbul University recently discovered this connection and have published their results as a "Rapid Communication" in *Physical Review C*.

Nuclear cross sections play a critical role in nuclear diagnostics and the production of the heavy elements in stars. Unfortunately, these quantities are frequently needed on short-lived nuclei where measurements are not possible. This new correlation offers the promise of both allowing simpler measurements to deduce the required quantities as well as providing insight for the nuclear theory used to make predictions where measurements are impossible. Neutron capture is a reaction in which a free neutron is absorbed by the nucleus, keeping the element unchanged, but changing isotopes. This reaction is typically exothermic. As a result, the reaction can proceed even when many other reaction channels are closed. In an astrophysical environment, this means that neutron capture is the primary mechanism by which all of the elements with atomic number greater than nickel are produced.

In a weapons context, neutron capture can compete with other processes, such as fission. This has several impacts. First, neutron capture can steal neutrons that could otherwise drive energy production. Second, it can change isotopic abundances. This affects both the material available to burn as well as provides a signature that could be used post-detonation to attempt to infer properties of the nuclear device or its performance.

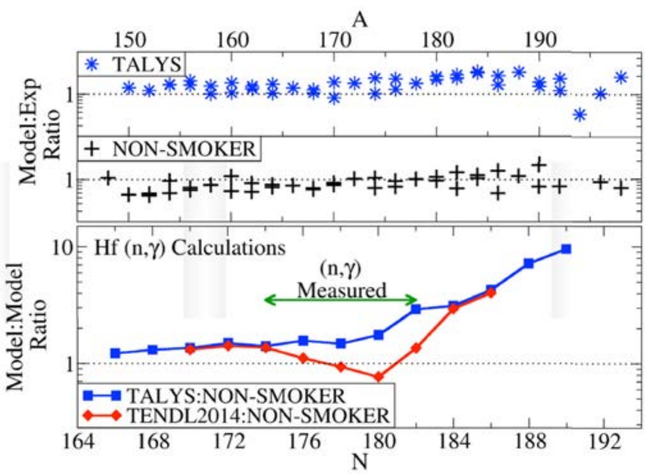


Figure 1: In the upper panel, several common statistical model code predictions are shown compared to measured cross sections. Nominal agreement is at the 40% level. In the lower panel, predicted cross sections are shown for hafnium isotopes but where measurements exist and off stability. The predictions quickly deviate by factors once measurements are not available to guide them.

As a result, understanding neutron capture reaction rates is a challenge for both fields. Among other activities, the Los Alamos Neutron Science Center enables neutron capture measurements for NNSA and other nuclear science needs. Unfortunately, many of the interesting isotopes are unstable, making direct measurements challenging. As a result, theory efforts have long worked to develop reliable reaction models that can accurately predict neutron capture rates, but the problem is difficult. They have met with only limited success. Figure 1 illustrates some of the challenges, but nominal agreement with data is limited to the 40% level.

Instead, the research team considered the connections between the reaction cross section and a nuclear structure property, the 2-neutron separation energy (S_{2n}). This is effectively comparing to the mass of the nucleus. As shown in figure 2, they discovered that the two are tightly correlated. This correlation can be used to provide predictions for the neutron capture cross section in regions where the cross section cannot be measured.

Despite its simplicity, this correlation had not been observed before this work. As part of the work, the team made predictions of neutron-capture cross sections for other nuclei of interest to both nuclear astrophysics and forensics. The initial focus is on isotopes in the rare earth region, but the correlation was also found to hold for other regions of the nuclear chart and temperatures ranging from kT=5-100 keV. This offers interesting possibilities in the actinides, where cross section measurements are quite difficult. It may be possible to define the correlation shape based on simpler measurements, and then infer the cross section for an isotope with

Continued on next page

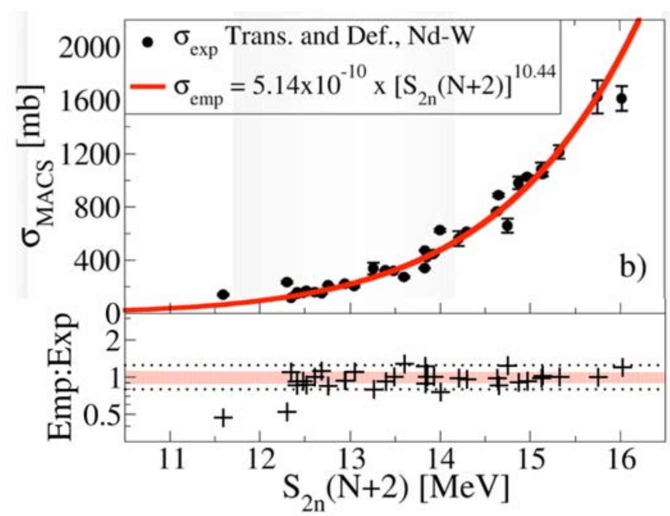


Figure 2: Above is the observed correlation between S_{2n} and the neutron capture cross section for a range of rare-earth nuclei. The 2-neutron separation energy (effectively nuclear mass) is strongly correlated with the neutron capture cross section. The σMACS is the "Maxwellian averaged cross section," an average cross section property particularly valuable in astrophysical environments in thermal equilibrium. The thermal temperature for the above cross sections is kT=25 keV.

HeadsUP!

Lab hosting series of events in April to celebrate Earth Day

Director Terry Wallace announced recently in a LANL-All memo that "in recognition of Earth Day on April 22, the Laboratory will host a series of events throughout the month to celebrate our commitment to sustainability."

The Laboratory's Earth Day theme for this year is "My Small Acts Make a Difference." To participate, employees are invited to share their small acts of environmental stewardship by writing them on recycled post-it notes on Earth Day "trees" that will be displayed at Otowi, NSSB, RLUOB Lobby (55-0400), the Material Science Laboratories (03-1698), TA-53 Bldg 1, TA-22 Access Center, and the Training Center in White Rock.

VPP recertification celebration

The Laboratory recently celebrated its recertification as a DOE Voluntary Protection Program (VPP) Star Site.

Since 2014, Los Alamos National Laboratory has held the title of the largest Department of Energy VPP Star site. Every Laboratory worker's visible contribution and demonstration of ownership and leadership in safety and security made this three-year recertification possible. Only DOE contractors with outstanding safety and health programs are awarded Star recognition, the highest achievement level.

As part of celebrations held across the Lab recognizing LANL's recertification as a DOE Voluntary Protection Program Star Site, employees at the Los Alamos Neutron Science Center enjoyed light refreshments and the opportunity to receive a commemorative keepsake.

Correlation cont.

high impact without having to perform an extremely difficult and expensive measurement.

This work supports the Laboratory's Stockpile Stewardship mission and the Nuclear and Particle Futures science pillar, with particular impact on the NPAC goals of Cosmic Explosions: Origins to Ashes and the Origin, Evolution, and Properties of Atomic Nuclei and the Applied Nuclear Science and Engineering goal of predicting nuclear reaction rates for stellar evolution and device performance. DOE/NNSA Science Programs (C1) (LANL Program Manager Ray Tolar/Morgan White) provided support for the LANL investigator (Aaron Couture, P-27) and R. F. Casten.

Reference: *Phys. Rev. C* **96**, 061601(R) (2017).

Technical contact: A. Couture

Celebrating service

Congratulations to the following Physics Division employees celebrating service anniversaries recently:

Adam Martinez, P-23	20 years
Anemarie DeYoung, P-23	15 years
Scott Hsu, P-24	15 years
Gerd Kunde, P-25	15 years
Petr Volegov, P-23	15 years
Jeremy Danielson, P-23	10 years
Per Magnelind, P-21	10 years
Changhyun Ryu, P-21	10 years
James Harding, P-23	5 years

PhysicsFlash

Published by the Experimental Physical Sciences Directorate

To submit news items or for more information, contact Karen Kippen, ADEPS Communications, at 505-606-1822, or adeps-comm@lanl.gov.

For past issues, see www.lanl.gov/orgs/p/flash_files/flash.shtml

Los Alamos NATIONAL LABORATORY EST. 1943